Title:: Device for Temperature and Humidity Control of Air

RELATED PATENTS

The patents listed below were examined to aid in the design for this invention. Any resemblance between the invention of this application and the above named inventions is slight.

5 884 492	mar 1999	Zwicky, et al.
5 850 968	dec 1998	Jokinen
5 127 233	jul 1992	Coffield
4 090 370	may 1978	Vaughan

BACKGROUND OF THE INVENTION

The invention described in this patent application relates to methods of heating or cooling air through a central air system. This invention also relates to devices designed to humidify or dehumidify air.

Many houses and offices have electronic controls that allow the adjustment of air temperature. These controls cue a heating system to operate when the air temp is below a certain value and prompt the engagement of an air conditioner when the temperature is above a certain value. These units are usually (in part or in whole) centrally located inside of a building as the hub of a system of air ducts that supply individual rooms with air that has been heated or cooled. For an invention to be profitable, it must be able to work within a central framework of ducts.

Humidifying and dehumidifying devices, on the other hand, are generally small and portable units designed to work in a single room or area of a building. The limitation in scale of the dehumidification or humidification that can take place is one of the things that this invention hopes to remedy; as the overall comfort level in a building is strongly dependent on the humidity. This is especially obvious in hot and humid climates. Maintaining a level of humidity can also be advantageous in cold climates. Certain health conditions such as dry skin and frequent nosebleed can be aggravated by continuous exposure to very low humidity levels typically found in the continental climates of the northern parts of North America and Eurasia. The benefits of an increased comfort level from humidification or dehumidification of indoor air are often outweighed by the cost of outfitting a building with enough portable units to effectively treat all the air. Coupled with the failure of most units to operate in both humidifying and dehumidifying capacities, the humidity is often left to fluctuate naturally.

The use of water to heat air primarily dates to the use of radiators, which when filled with hot water were very effective at heating the room in which they were located. The shortcoming of this system was that they often worked too well, making a room uncomfortably warm. The system also required the bulky radiators themselves to be placed in each room. These radiator units were also capable of becoming hot enough to cause burns when touched or to damage objects that were mistakenly placed too near to them. The positives of this system were in its simplicity, as well as taking advantage of radiant heat, hence the name. Another useful dimension to these units was they high specific heat of water that filled them. Once heated, moderate amounts of water could easily heat a large area, and the water could be kept warm efficiently.

Attempted solutions to the problem of total climate control have not yet caught on. One reason this may be the case is that too much emphasis is placed on energy efficiency and not enough on the precision of the machinery. US patent # 4 090 370 attempts to humidify air by passing it over a porous, fabric like material that has been sprayed with water. While somewhat effective, it seems that it would be difficult to maintain a constant level of humidity. In the same patent, the air is humidified before it is dehumidified, and this invention adopts a similar strategy. Also in patent # 4 090 370 condensation is caused by the heat of evaporation of the sprayed water, a method that also lacks accuracy and precision.

BREIF SUMMARY OF THE INVENTION

This invention is a simple solution to the control of the two main variables of air: temperature and humidity. It is one unit designed to replace four (heaters, air conditioners, humidifiers, and dehumidifiers). This invention is designed to work within a central air framework, and therefore is compatible for installation into most buildings. This capability to work as in a central air framework also means that the entire building will have the benefits of the device. If equipped with reasonably sensitive temperature gauges, the invention will be able to exert accurate and precise control over both the temperature and the humidity. This is because water will be used as the main heat transfer medium and its high specific heat allows its temperature to be held nearly constant when its volume is of reasonable size in comparison with the flow rate of air through the machine. The humidity of the air will be manipulated by passing it through a

volume of water to absorb moisture and to filter the air, then a system of cooler piping to remove the moisture, and then the final temperature of the air will be set by piping that is in thermal contact with the first volume of water. The dehumidification of the air can be made to be more complete by the addition of a valve that allows both chambers to be pressurized. The pressurization also gives the unit the ability to sterilize the air by allowing the humidification water to exist at temperatures above 100 C.

BREIF DESCRIPTION OF THE DRAWINGS

Figure 1

1. air intake
2. air pump or blower
3. control unit
4. humidification vat bypass valve
5. bubbler valves
6. humidification vat filled with water
7. to holding tank
8. from holding tank
9. overflow valve (airtight)

9a . water input valve

10. insulation
11. air/water valve
12. dehumidification area
13. heat transfer piping
14. to holding tank
15. from holding tank
16. adjustable pressure valve

16a. exhaust air

Figure 2

17. to humidification vat
18. from humidification vat
19. to dehumidification piping
20. from dehumidification piping
21. heating coils
22. evaporation coils
23. valve for determining flow rate to each evaporation coil
24. from condenser
25. gas compressor
26. to condenser (usually located outdoors)
27. expansion valve
28. temperature sensor
29. circulation fans or pumps
30. one way valves
31. electrical connection

DETAILED DESCRIPTION OF THE INVENTION

The invention can be best understood as the combination of three different cyclic processes: the air cycle, the water cycle, and the coolant cycle. Each of these cycles will be discussed in detail along with the way interact.

The air cycle begins by taking air into the device (1). This intake is usually located within the building, but fresh air can be introduced from also. When the temperature and/or the humidity of the building is outside a set acceptable range, the control device (3) prompts the operation of an air pump or blower (2) that begins to cycle air through the device. Under the normal operation mode, air is lead to a series of valves (5) located at the bottom of the humidification vat (6). These valves allow air to be bubbled through a vat of water and can humidify or dehumidify the air depending on the temperature of the water and the dew point of the air. Should the bubbles be sufficiently small, the air should be very nearly saturated with water vapor. Opening of the humidification vat bypass valve (4) allows air to skip this step in order to conserve energy when no humidity control is necessary. Air then passes through the air/water valve (11) which is present in combination with thermal insulation (10) between the humidification vat (6) and the dehumidification area (12) to decrease the rate at which these two parts (which are most often at different temperatures) reach thermal equilibrium when air is not circulating. The air/water valve (11) also allows condensed water from the dehumidification area (12) into the humidification vat (6).

The air then moves into the dehumidification area (12). While in the dehumidification area (12), the air makes contact with heat transfer piping (13). The

amount of condensation that can collect on these pipes depends on their temperature relative to the humidification vat (4), or, more generally, the dew point of the incoming air. Colder pipes can remove a greater amount of moisture from the air. This process can be augmented by an adjustable, pressure sensitive valve (16), that allows for greater air pressure.

From the dehumidification area (12), air then moves into piping that leads through the humidification vat (6). If that piping is of a large enough surface area, the air that passes through it should be in thermal equilibrium with the surrounding water in the humidification vat (4). Air then exits the device (16a) and enters the ductwork of the building. The motion of air throughout the building can be expedited by the use of fans at this stage.

The water cycle is the process by which water heated and cooled. This water is used as the primary heat transfer medium in the air cycle. The heating and cooling of water takes place in a holding tank where heating coils and the evaporation coil of a heat pump is located. Fans or other methods of moving the water (29) keep the water at nearly the same temperature throughout its continuous fluid volume, including that which is transferring heat to or from the air within the unit.

The water level of the humidification vat (6) can vary, so an airtight water overflow valve (9) must be introduced, as well as a water input valve (9a). Thermal sensors (28) that are connected to a control unit not pictured in the drawings turn on electric heating coils if a particular water volume is colder than the settings specify. Should the water become warmer than the specified settings, the coolant cycle must be used.

The coolant cycle is not unlike a common air conditioner unit with the evaporator located in thermal contact with the holding tanks, and the condenser located in a heat sink (usually the outdoors). The coolant cycle has a gas compressor (25) that aids in the liquefaction of the coolant gas and an expansion valve (23) that leads into the evaporator. One of the differences in the mechanism is that the expansion valve can divide the fluid moving to either of the evaporators (22) in any proportion. In other words, when only one holding tank needs to be cooled, this valve can exclude the other holding tank from the cooling process. The other difference between the coolant cycle used here and other air conditioners is that the gasses that have passed through the evaporators must pass through one way valves (30) on their way to the compressor. These valves exist to prevent the flow of gasses into an evaporator for which they were not intended.

In summary, the invention described works to independently heat or cool 2 liquid volumes, one of which is water. Air then thermally contacts these liquid volumes and its temperature and humidity is changed. Air is first humidified by bubbling it through a volume of water, then dehumidified by thermal contact with pipes colder than the volume of water. The air stream is then directed back through the volume of water where it achives its final temperature before being ejected from the machine.